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have proceeded to examine the several Matters to them referred, and have agreed to the following Report :

**Y**OUR Committee having proceeded to consider the important subjects recommended to their attention, have thought it incumbent upon them to lose no time in reporting to the House some particulars given in evidence to them, which are not only connected with the preservation of the roads, but also in other respects interesting to the public.

By an act passed in the year 1788 (28 Geo. 3. c. 57.) regulations were made for the purpose of limiting the number of persons permitted to travel on the outside of stage coaches or other carriages: and this law was afterwards altered, explained, and amended by an act passed in the year 1790, (30 Geo. 3. c. 34.) by which additional provisions were enacted.

It appears to your committee that the salutary regulations provided by these acts have been by a variety of contrivances most grossly evaded, inasmuch that instead of six (the number limited by the original act) twenty passengers and more are often carried on the outside of stage coaches. It is not unusual to see ten on the roof, three on the box (besides the driver) four behind on what is called *the gamon board*, and six on the dicky or chair; in all, often above thrice the number intended to be allowed.

These evasions of the law are in several respects of great public disadvantage.

1. It cannot be doubted that machines conveying such a number of persons and their luggage must be extremely destructive to the Roads: the wheels are narrow, and the weight great; and as these carriages are not liable to the regulations regarding weighing engines, the weight they carry has no limit.

2. From the enormous weight, and the injudicious manner in which such numbers of passengers and their luggage are so frequently conveyed, namely on the roof (which renders the carriage top heavy, and apt to be overturned) accidents are perpetually happening in one part of the kingdom or another; and indeed scarce a week passes without some of those carriages breaking down, and often

killing the unfortunate passengers who have trusted themselves to that mode of conveyance. Within these few days the Croydon coach broke down, from its being overloaded, in consequence of which two persons lost their lives, and several others were severely bruised. For a variety of other instances of the same sort, your Committee beg leave to refer to the Appendix.

Your Committee are persuaded that it is unnecessary for them to dwell any longer upon a subject which they humbly conceive is well entitled to the immediate attention of parliament, by whose authority such disgraceful and dangerous practices can alone be prevented.

#### *Second Report of the Committee on Acts relating to Broad Wheels, &c. \**

**Y**OUR Committee have already communicated to the House some information regarding the subject which they were instructed to consider, namely, "The Regulations as to the Number of Outside Passengers to be conveyed in Stage Coaches;"—They now beg leave to report on the two other points recommended to their attention, namely, 1. The System that ought to be adopted for the greater Ease of Draught in Carriages; and, 2. The best means of preserving the Turnpike Roads and Highways of the Kingdom.

From the late period of the session at which your Committee was appointed, they find it impossible to do that justice which they could wish to these important investigations; at the same time they trust, that the information they have collected, and which they now beg leave to submit to the consideration of the house, contains some useful suggestions, which, aided by further inquiries in the course of some future session, will enable parliament to form such a system regarding the public roads, as may be of the most material service in promoting the general interests of the kingdom.

#### *1. Observations respecting Ease of Draught in the Conveyance of Goods.*

Ease of draught, independent of the state of the roads, which will be afterwards considered, must principally

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\* Published in July 1806.

depend on two circumstances: 1. The general nature of the carriage made use of; and, 2. The construction of the wheels.

### 1. *Carriages.*

A variety of carriages have been adopted in different countries, from the sledge to the waggon, with wheels, rolling a surface of sixteen inches each, dragged by from eight to ten, and even twelve horses, and conveying, according to the laws now in force, eight tons in weight.

Waggons upon the largest scale may certainly be economical to the proprietor, more especially where the wages of men are high, as one trusty person, with an assistant at inferior wages, can manage a number of horses, and convey, with the like number of horses and attendants, greater burdens, in proportion to the expense, than can be carried on the public roads in any other manner (single horse carts, where two or three can be conducted by one person, as is practised in Scotland, alone excepted) and, if there were no objections to the use of waggons, on account of the destruction which they occasion to the roads (the reparation of which is attended with so heavy an expense to the public) the use of them would be deserving of encouragement, more especially in a commercial country, where it is important that goods should be conveyed at as moderate an expense as possible. But your committee are led to believe, from the information which they have acquired, that there are scarcely any materials of which our roads are formed, that can bear the pressure of such enormous\* weights as these waggons are now allowed by law to carry; in addition to which it may be stated, that the form of their wheels or rollers, whose felnes are sixteen inches broad, and, as now constructed, of a conical shape, is particularly injurious to the road, as will be more fully explained hereafter.

Mr. Russel, of Exeter, one of the most considerable carriers in the kingdom, who is in the habit of using no less a number than two hundred and twenty-four horses, in waggons with wheels having felles nine inches in

breadth, having endeavoured to improve the construction of his waggons as much as possible: an engraving of one of those waggons, with an account of the dimensions thereof, is annexed.\*

Machines with two wheels, for conveying goods and other articles, are known under the general name of carts or cars. Of these, single horse carts are in many cases to be preferred; for, though they cannot be adopted with equal advantage where roads are crowded with carriages, and each cart must have a distinct person to attend it, yet where one person can take the charge of two or three single horse carts, which is the case in some parts of the united kingdom, there are no means by which a great quantity of goods can be conveyed at so small an expense.

Carts with two horses abreast have been tried in some counties; but those in use are said to be injurious to the roads, from the enormous weights they convey on narrow wheels. It has also been suggested, that carts with three horses abreast might be advantageous. If they were restricted to wheels whose tire was of a breadth proportionate to the weights they were allowed to carry, and of a cylindrical form, the value of this species of cart would be particularly felt in hilly countries, not only as all the horses could be more easily managed by the driver, so as to oblige them to act with all their force together in dragging the machine up-hill, but they would also be equally employed in resisting the weight of the carriage in the descent.† This kind of machine, if it answers the expectation formed of it, might be of considerable service in his Majesty's ordnance and military departments.

On the whole, the proper form of carriages for the conveyance of goods, in different circumstances, is a subject which still requires further investiga-

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\* Appendix, No. ii.

† There is reason to believe that Mr. Cooke, of Chute House, near Andover, will build a waggon on a new construction, to be drawn by three horses abreast, and that Mr. Russel, the Exeter waggoner, will make use of it for some time, so as to give it a fair trial.

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\* Appendix, No. i.

tion, and accurate experiments, before the principles thereof can be fully ascertained.

### 2. *Wheels.*

This extensive subject may be considered under the following general heads: 1. The form of the rim or felly; 2. The nature and position of the spokes; 3. The breadth of the wheels; 4. Their height, and the line of draught; 5. The position of the axle; 6. The weights allowed to be carried; and, 7. The experiments necessary to be tried, for the purpose of ascertaining the nature of the wheels, and the construction of carriages best calculated for ease of draught in different circumstances.

#### 1. *Form of the rim and felly.*

The rims of all wheels that have an equal bearing on their whole breadth must either be of a cylindrical or conical form. Some are rather rounded; and in some cases the law is evaded by a single stroke being raised above the general surface of the tire; by which means wheels of a considerable breadth, having but a narrow bearing on the road, operate as injuriously on them as narrow wheels.

Your committee understanding that Mr. Cumming, of Pentonville, has long paid particular attention to this branch of the subject, and that he had contrived machinery, by which the effects of cylindrical and conical wheels, both in regard to the preservation of the roads, and the labour of the cattle, were ascertained, they requested his attendance.

It appears from the information with which he furnished your committee, that in the acts which have been passed for proportioning the breadth of cart and waggon wheels to the weight of the loaded carriage, it was a condition, that the wheel should be *flat on the sole*, so as to have an equal bearing on its whole breadth; and this description has for very many years been thought sufficient to secure all the advantage that could be gained by increasing the breadth of the wheel. But it appears that this description applies equally to wheels whose rims are of a cylindrical or of a conical shape, although the effects of those different shapes

on the roads, and on the labour of the cattle, are not only different, but very contrary to each other: and it has unfortunately so happened, that the most unfavourable has been universally adopted.

Mr. Cumming, in an essay on that subject, has compared and contrasted the properties of the cylinder and of the cone, and from them has demonstrated the effect which broad wheels, of the conical and of the cylindrical shape, must have on the roads, and on the labour of cattle; that wheels of a conical shape have a constant tendency to impair, and those of a cylindrical shape to improve them. By a most ingenious and well adapted apparatus, he has exhibited to us experiments (an account of which will be found in the Appendix) from which the following facts may be deduced.

That there is a resistance from the partial dragging at the periphery of every wheel that is of a conical shape; that it grinds the hardest materials, and leaves the surface of the roads in a state to imbibe water, and adds considerably to the labour of the cattle; and that this resistance, so injurious to the roads, and to the cattle, is increased, by increasing the breadth of the conical wheel.

That wheels that are cylindrical have no such dragging at their circumference, no such grinding or deranging of the materials; and that the cylindrical wheel, by its progressive dead pressure, consolidates and unites the materials, and leaves the surface smooth, close, and impenetrable to water; and that on a regular, well-formed, clean road, the resistance to the progress of the cylindrical wheel is not increased by increasing the breadth; and that the cylindrical shape is the best possible, it being the only form of the rim that can have an equal velocity of all the parts of its periphery.

Mr. Cumming, in his essay, has enumerated nine resistances which occasionally obstruct the progress of a carriage; but that of the dragging of the conical rim being the only one that is constant, and the least attended to, it is herein exclusively considered.

With deep snow, deep sludge, and in general with deep roads, the resistance to the front of the wheel increases with its breadth; and for this reason it may be proper to recommend for the present no greater breadth than from 9 to 12 inches; and as many broad wheels are now made, that are rounded on the sole or periphery, and they are neither a part of a perfect cylinder or cone, their properties must be estimated according to their affinity to the one or the other. But as all these have not an equal bearing on their whole breadth, they must partake in a proportional degree of the disadvantages of narrow wheels; they form the surface of the roads into fûts or flutes, and, by constantly shifting the materials, they keep the surface in a state ready to admit water, and this increases the bad effects of hard frosts.

The various circumstances that are stated by Mr. Cumming, in his essay, of the comparative merits of conical and cylindrical wheels, appear to be well warranted by the experiments which have been repeatedly performed before your Committee, and lead to the following conclusions: 1. That when wheels are very narrow, there is little difference in the power required to draw the same load, whether they be conical or cylindrical: 2. That in conical wheels, the power required to draw the same load (on the best and smoothest roads) is considerably increased, by increasing the breadth of the wheels, and that all the increase of labour of the cattle is applied to the destruction of the road: 3. That on the cylindrical wheels, the same power draws the carriage upon smooth roads with equal ease, whether the wheels be broad or narrow; but by the use of such broad wheels, the roads, instead of being destroyed, are consolidated and improved: 4. That great fluctuations take place in the power necessary to draw the same load on conical wheels, according to the circumstances of the wheel bearing on the narrow parts of its rim, on its whole rim, or on the extremities of its rim: 5. And that no such difference of resistance happens, under the same circumstances, with the cylindrical broad wheels: 6. And that

from every circumstance, the cylindrical wheel is preferable to the conical, in every state of the roads; and in whatever state they may be, the cylindrical improves, and the conical impairs them: 7. That the general conclusion, from all the experiments that have been exhibited before your Committee, is, that so far as regards the preservation of the roads, and the labour of the cattle, the cylindrical shape of a wheel is preferable to any other possible shape, it being the only one that has the same velocity at every part of its rim, and that has no dragging or rubbing, nor any tendency to grind or derange the materials, nor to leave the surface of the road in a condition to imbibe or to admit water.

These conclusions appear to your Committee to be fully warranted by the reasonings offered in support of them, and fully supported by the experiments which we have seen; and although we are of opinion that it will be advisable to make accurate experiments with carriages of full size, to determine the quantum of the difference between the effects of conical and cylindrical wheels in practice, the evidence already before the Committee leaves no room to doubt that much advantage must be gained in the gradual improvement of the roads, and in saving the labour of cattle by the gradual introduction of cylindrical wheels of moderate breadth, which may be increased as the roads are improved, and as prejudice against them subsides.

From the illustrations which Mr. Cumming has produced, of the contrary effects which wheels of a cylindrical and conical shape must have on the roads, and on the labour of cattle, and the very satisfactory experiments by which every conclusion was supported, it may be presumed, that much benefit might be gained by his investigating general principles for constructing wheel carriages, and by illustrating the principles by experiments in the manner which he has already adopted. But it cannot be expected that any individual, possessed of but a moderate income, and having a family to maintain, can devote his attention almost exclusively to so intricate and extensive a subject, without a remuneration ade-

quate to his labour, and the advantages which the public must necessarily derive from his zeal and services.

It having been thus proved, that the cylindrical shape of the rim is the most advantageous (a discussion on this subject will be found in the appendix) the disposition of the spokes claim the next attention.

### 2. The Spokes.

These are the radii of the wheel, and connect the nave with the rim or fellyes.

Their position may be perpendicular to the axle; 2. oblique, or dished; or, 3. double dished. When the spokes stand square, or at right angles, to the axis, they derive no other advantage from that position than the actual strength of the timber of which they are made, and are calculated only to bear a perpendicular pressure. When the spokes stand oblique, it gives the wheel a concave appearance on the side that is the furthest from the carriage, which is called *dishing*; and the dishing gives to the wheel, in some positions, much additional strength, from the affinity which it has to an arch. It is possible, that the dishing of the wheel was a consequence of the bending of the axis; and it being found that the dishing of wheels was attended with other advantages besides strength, they have been universally preferred. When the obliquity of the spokes is adapted to the bending of the axis, those that are immediately below the axis stand perpendicular to the surface of the road, in which position they are the best able to resist the perpendicular pressure of the load, but are the less able to resist lateral jolts.

But if the dished wheel be applied to a straight axis, the spokes will more advantageously resist the oblique pressure on a sloping road, or any accidental lateral jolt.

*Spokes that consist of two rows*, and that are dished in opposite directions, have of late years been occasionally used in low wheels, where much strength is required; as each row of these spokes have all the advantages of the single dishing, and as they are directed towards the opposite sides of the wheel, it must be much stronger than the single row, and much better adapted to resist lateral shock in both directions.

The *double-dishing* seems peculiarly

calculated for wheels whose rims are of considerable breadth, as the spokes may be so applied as to give a double support to the rim or fellyes, as well as stability against lateral jerks.

### 3. Breadth of the Wheels.

It has been proved, by the experiments made by Mr. Cumming before your Committee, that when the rim of a wheel is made truly cylindrical, so as to have an equal bearing on its whole breadth, that the resistance to its progress on a smooth regular surface is not increased by increasing its breadth; and the advantages of a broad bearing of a wheel on the road are too obvious to be doubted: but as deep snow, deep sludge, or deep roads must obstruct the progress of a broad wheel more than the narrow, experience and local circumstances must ultimately determine the breadth of wheels fit for general use. But it should ever be held in remembrance, that the narrower the rim, the more damage it does the roads; and if cylindrical, the broader it is, consistently with other circumstances, the more it improves them. It seems deserving of consideration, whether the wheels of stage coaches, &c. ought not to be made broader than at present, considering the very great weights which they frequently carry.

### 4. The Height of Wheels.

The opinions regarding the height of wheels are various, even among men of science, some estimating the advantages of high wheels by the greater facility with which they surmount fixed obstacles, and the diminution of friction on the axis: but as fixed obstacles are removed on all turnpike roads and highways, the first consideration is no longer of importance; and the friction on the axis is only reduced to one-half with a wheel of twice the height. But if the double weight of the high wheel in drawing up hill be compared with the diminution of the friction on the axis, it will be found on a general average to exceed out of all comparison. From which consideration, it would seem that wheels of a moderate height ought to be preferred, unless where particular circumstances may recommend the higher wheel.

The most advantageous direction of

the line of draught in wheel carriages is a subject of great importance, but in some instances involved in so much intricacy, that it does not yet appear to have been sufficiently investigated in particular cases: it is therefore an object worthy of serious consideration to determine it in all its varieties, as well in a practical as a theoretical view.

##### 5. *The position of the Axis.*

The axles of all carriages were probably at first made straight, and the wheels cylindrical, for in the earliest and simplest carriages the wheels were fixed on the axle, which turned with them; and this appears to be in several respects preferable to any other position of the axis. But when the size of carriages was increased, and the road remained yet very narrow and the ruts deep, it became necessary to bend the ends of the axles downwards, to give room for the body of the carriage, and to bring the lower part of the wheels so close together, as to run in the old deep ruts. But now that the roads have no such deep ruts, there is no longer any such necessity for bringing the wheels of such carriages as travel the turnpike roads, closer together below than at top; the straight axis is naturally adapted to the cylindrical rim, and will probably be found, in practice, as well as in theory, the best position for the axles of wheel carriages, excepting only those of carriages of pleasure in the metropolis, and other populous cities: but this ought not to affect the general construction.

Besides the bending the ends of the axles of waggons downwards, as before stated, another bending of the axis has been practised by some, since the divergency of the conical wheels has been discovered: in order to counteract the tendency of the conical wheels to draw further from each other in their progress, they bend the ends of the axis *forward*, to make the front of the wheels to come as close to each other at the front, as at the lowest part of the wheel, conceiving that by thus giving the wheels a convergency or tendency to come closer together in their progress, that would balance the divergency that would arise from the conical shape of the wheel; thus vainly conceiving, that,

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by giving the wheel another tendency, in direct opposition to that of the conical wheel, the one would remedy the other. But instead of curing the evil arising from the conical shape of the wheel, this intended remedy however plausible, will be found to double the evil which it was intended to remedy.

##### 6. *Weight allowed to be carried.*

Various acts of parliament have settled the weight to be carried according to the breadth of the wheels; of which the following table gives a general view.

Waggons with four wheels or rollers, of the width of

<i>Inches.</i>	<i>In Summer. Tons. Cwt.</i>	<i>In Winter. Tons. Cwt.</i>
16 are allowed	8. 0.	7. 0.
9 rolling 16 . . .	6. 10.	6. 0.
9 . . . . .	6. 0.	5. 10.
6 Do. 11 . . . .	5. 10.	5. 0.
6 . . . . .	4. 5.	3. 15.
Under 6 . . . . .	3. 10.	3. 0.
Carts with		
9 . . . . .	3. 0.	2. 15.
6 . . . . .	2. 12.	2. 7.
Under 6 . . . . .	1. 10.	1. 7.

Your Committee at the same time are of opinion, that some alterations ought to be made in that table, according to the proportion specified in the appendix.

##### 7 *Experiments to be tried.*

It appears, on the whole, that there remain still so many doubtful points to be ascertained, on the subject of wheels, that it would be desirable to institute a complete set of experiments; for the purpose of fixing the principles on which they ought to be constructed. These experiments should include each of the various particulars above alluded to, and ought to be tried, not in a cursory manner, but for a considerable period of time, in situations best calculated to produce results which can be depended upon for their accuracy and universality.

It would not be difficult to ascertain the effect of each particular point connected with the construction of wheels, in so far as regards the labour of the cattle alone, and the strength of wheels of different construction; but as to their effects upon the roads, it should seem to be necessary to make experiments on them through all the various circumstances of the different seasons of the year. Perhaps there are no means by which these points could be so well ascertained as if the

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experiments were undertaken by so valuable an establishment as the Board of Ordnance, who are materially interested in the result of such enquiries, and under whose inspection the experiments could be carried on with every possible advantage.

### *II. Preservation of the Roads.*

It must be obvious that, notwithstanding any improvements which may be made, in the general construction or mode of conducting our carriages, or in the form and proportion of their different parts, and more especially of the wheels; however accurately all these may be contrived, according to true mechanical principles; yet if equal care and attention is not paid to the original formation; and, what is perhaps of equal importance, to the constant preservation of the roads, all the prudence of the economical carrier, all the ingenuity and skill of the mechanic, are of little avail.

The man of curiosity who travels for his pleasure; the man of business who traverses the country in pursuit of his affairs; those whose occupation it is to supply one part of the kingdom with the produce of the other, or to convey from the interior to the sea ports the articles of our industry for foreign consumption; and those who are to be supplied by these means with the necessities or luxuries of life; are equally disappointed in their hopes, and where they look for pleasure, security, economy and expedition, they have to encounter fatigue and danger, expense and delay. Next to the general influence of the seasons and of the weather, (upon which we so much depend for the regular supply of our wants, and for a great proportion of our comforts) there is perhaps no circumstance more interesting to men in a civilized state, than the perfection of the means of interior communication: and it is deservedly our boast, that more attention has, upon the whole, been already paid to this important object, in this country, than almost in any other part of the world.

The best modes of forming roads are now indeed pretty well understood, and carried into execution in most parts of the kingdom; but some regulations appear still to be wanting for their due preservation and management.

Upon these heads your Committee have received several useful suggestions, which they have added, by way of Appendix, as containing matters highly worthy of the consideration of the House.

### *Conclusion.*

The general question of roads, and of the carriages conveyed upon them, would require much more time and attention, than it has been possible for your committee to bestow, since the period of their appointment. They beg, however, to allude to some particulars which have come under their consideration, and respecting which various suggestions have been collected in the course of their proceedings.

1. The first relates to the improvements which might be made in the general laws regarding highways and turnpikes. A number of hints have been transmitted to your Committee from various quarters, which are inserted in the Appendix, where any person desirous of investigating the subject, will have an opportunity of examining them\*. Your Committee are decidedly of opinion that these laws require to be re-considered; and perhaps it would be most advisable, though it would be an arduous task, to repeal the former laws, and to form the whole into one regular digest, which, from the experience of so many years since the laws were first enacted, may be considerably amended and improved.

2. With a view to the greater safety of passengers, whose lives are now so often endangered by public vehicles of different descriptions, a coach has been invented by the Rev. Wm. Milton. Your Committee do not hazard an opinion on the merits of this invention, which should be ascertained and established by adequate trials. They have thought it right, however, to insert in the appendix an account of the invention.

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\* Your Committee would also recommend to any person desirous of fully and accurately investigating this subject, the perusal of a valuable work, written by John Scott, esq. late a very active magistrate in the county of Herts, under the title of "*Digests of the general highway and turnpike laws.*"



3. The idea of conveying goods and carriages on railways is likely to prevail, the more the subject is considered. In many cases railways are certainly preferable even to canals, and wherever they can be adopted, they are unquestionably better calculated than the common roads, for the conveyance of goods, more especially those of a heavy nature. An idea has occurred, of forming what may be called *stone railways*. Your Committee have thought it right to give a short account of the plan, in the Appendix, with an engraving, to explain one mode by which this may be effected. Any new idea of that sort, thrown out for the consideration of ingenious men, may possibly be improved, so as to turn out of public utility. Probably the mode which has been already adopted, in the commercial road, leading from the West India docks, may be considered as an improvement of this plan; the centre of that road is paved of a convenient breadth for the use of carriages heavily laden, while the lighter carriages, and horses, pass with ease on each side on a road formed in the usual manner.

4. The direction and the forming of roads are also points which merit the attention of parliament. As to the first particular, it is well known that the roads in former times were not conducted in the manner the best calculated for the travelling of carriages heavily laden. Their course was frequently carried up steep ascents, to gain the open country, and avoid the vallies, because the roads through the latter could not easily be

made passable in the wet seasons of the year, without a labour and expense which it was perhaps then thought unnecessary to incur, when most, even of the heavy articles of trade, were carried on the backs of horses. Your Committee are of opinion, that by examining the lines of the present roads, much improvement might be effected. Any such alterations must necessarily occasion expense, and may be liable to some objections; at the same time it is well worth the trial, and the first attempt might be made on the great line of road between London and Edinburgh, by which the capitals of the two kingdoms would be more closely connected; and if the advantages were found to be considerable, the same plan might afterwards be extended to other lines. On that subject your Committee beg to refer to a paper which will be found in the Appendix, and which explains the nature of such a plan, and the means of carrying it into effect.

On the whole, your Committee have endeavoured in this Report, and in the Appendix annexed to it, to furnish such information as they trust may be of service, when these particulars come again under the consideration of the House. The points they have alluded to in the Report are of such infinite consequence to the convenience, the comfort, the commercial prosperity, and the personal security of their fellow subjects, that they will feel peculiar satisfaction, if any suggestions, which it has been in their power to collect, shall at all contribute to such important purposes.

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#### BIOGRAPHICAL SKETCHES OF DISTINGUISHED PERSONS.

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*Historical Eulogium on Joseph Priestley, Read at the public sitting of the National Institute, in the class of mathematical and physical sciences, the 5th of Messidor, year 13 (1806) by G. Cuvier, perpetual secretary of the first class of the National Institute, and professor of the College of France, and of the Museum of Natural History. Translated by*

*the Rev. D. B. Warden, M. A. and Secretary to the Minister Plenipotentiary of the United States of America. Paris.*

GENTLEMEN,

I HAVE to address you on the subject of the life and works of Doctor Joseph Priestley, an English ecclesiastic, born at Fieldhead, near Bristol